

## CLAIMS

What is claimed is:

1. A method of determining an arrival time of a received signal comprising two or more multipath components, the method comprising:

5 using a sub-optimal estimation algorithm to identify one or more time windows; and determining a time estimate for one or more multipath components of said received signal by using an optimal search algorithm bounded by said time windows.

10 2. The method of claim 1 wherein using a sub-optimal estimation algorithm to identify one or more time windows comprises:  
processing said received signal to identify an approximate time estimate for one or more multipath components of said received signal; and  
defining said one or more time windows as one or more spans of time encompassing a range of time around said approximate time estimates, such that said optimal search algorithm operates within a reduced search space.

15 3. The method of claim 1 further comprising:  
assuming a maximum number of multipath components for at least one of said one or more time windows; and  
20 restricting said optimal search algorithm to estimation trials involving no more than said maximum number of multipath components for said at least one time window.

25 4. The method of claim 1 wherein using a sub-optimal estimation algorithm to identify one or more time windows comprises processing at least a portion of said received signal using a Multiple Signal Identification and Classification (MUSIC) algorithm.

5. The method of claim 1 wherein using a sub-optimal estimation algorithm to identify one or more time windows comprises processing at least a portion of said received signal using a correlation algorithm.

5 6. The method of claim 5 further comprising iteratively applying said correlation algorithm to said received signal to better resolve one or more correlation peaks in said received signal corresponding to said one or more multipath signals comprising said received signal.

7. The method of claim 6 further comprising restricting said optimal search algorithm to time windows defined around said one or more correlation peaks.

8. The method of claim 1 wherein using a sub-optimal estimation algorithm to identify one or more time windows comprises processing at least a portion of said received signal using a Signal Eigen Vector (SEV) algorithm.

9. The method claim 1 wherein said optimal algorithm comprises a maximum likelihood estimation algorithm.

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10. A method of determining an arrival time for a received signal having multipath signal components, the method comprising:

processing said received signal using a sub-optimal algorithm to identify one or more time intervals corresponding to one or more probable multipath signal

arrival times; and

generating a time estimate for said received signal based on resolving said one or more probable multipath signals within said one or more time intervals using an optimal search algorithm restricted to said one or more time intervals.

11. The method of claim 10 wherein resolving said one or more probable multipath signals within said one or more time intervals using an optimal search algorithm restricted to said one or more time intervals comprises:

defining a plurality of time positions across at least one of said time intervals, wherein said time positions are spaced apart according to a desired time resolution for resolving said arrival time of said received signal; and

applying said optimal search algorithm to said plurality of time positions to identify a Maximum Likelihood (ML) time position within said time interval.

12. The method of claim 10 further comprising assuming a maximum number of multipath signals for said received signal for use by said optimal search algorithm if processing said received signal with said sub-optimal algorithm does not yield a probable number of multipath signals.

13. The method of claim 10 wherein processing said received signal using a sub-optimal algorithm to identify one or more time intervals corresponding to one or more probable multipath signal arrival times comprises:

identifying one or more received signal peaks; and

5 applying a threshold function to said one or more peaks to define said one or more time intervals.

14. The method of claim 10 wherein processing said received signal using a sub-optimal algorithm to identify one or more time intervals corresponding to one or more probable multipath signal arrival times comprises correlating known information with at least a portion of said received signal.

15. The method of claim 14 wherein correlating known information with at least a portion of said received signal comprises correlating a sequence of known values with a sequence of said received signal transmitted as said sequence of known values.

16. The method of claim 15 further comprising iteratively correlating said received signal to better resolve correlation peaks corresponding to at least some of said multipath signals comprising said received signal.

17. The method of claim 16 wherein iteratively correlating said received signal to better resolve correlation peaks corresponding to at least some of said multipath signals comprising said received signal comprises canceling correlation peaks identified in a previous correlation iteration in each successive correlation iteration until no new correlation peaks in said received signal are identified.

18. The method of claim 16 further comprising restricting said optimal search algorithm to a time window around at least one of said correlation peaks identified by said iterative correlation.

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19. A method of determining an arrival time for a received signal having multipath signal components, the method comprising:

processing said received signal to identify one or more multipath components;

canceling said identified multipath components; and

5 repeating said processing and canceling steps iteratively until the multipath components identified at a previous iteration substantially match the multipath components identified at the current iteration.

10 20. The method of claim 19 wherein processing said received signal to identify one or more multipath components comprises processing said received signal using a sub-optimal processing algorithm.

15 21. The method of claim 20 wherein processing said received signal using a sub-optimal processing algorithm comprises using a MUSIC algorithm to process said received signal.

22. The method of claim 20 wherein processing said received signal using a sub-optimal processing algorithm comprises using a correlation algorithm to process said received signal.

20 23. The method of claim 19 wherein canceling said identified multipath components comprises treating the identified multipath components as noise, which noise is filtered during processing said received signal in the next iteration.

24. The method of claim 23 wherein treating the identified multipath components as noise comprises updating a noise correlation matrix at the beginning of each processing iteration based on the identified multipath components from the previous iteration, wherein said noise correlation matrix is used to identify multipath components in each processing iteration of

5 said received signal.

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25. A receiver operative to estimate a time of arrival of a received signal, the receiver comprising:

a sub-optimal algorithm processor to process said received signal using a sub-optimal algorithm to generate crude estimates for one or more multipath components of said received signal; and

an optimal algorithm processor to refine said crude estimates for said one or more multipath components of said received signal, such that an arrival time of said received signal may be estimated.

26. The receiver of claim 25 wherein said sub-optimal algorithm processor comprises a MUSIC algorithm processor.

27. The receiver of claim 25 wherein said sub-optimal algorithm processor comprises a correlation algorithm processor.

28. The receiver of claim 25 wherein said sub-optimal algorithm processor comprises a Signal Eigen Vector (SEV) algorithm processor.

29. The receiver of claim 25 wherein said optimal algorithm processor comprises a Maximum Likelihood (ML) algorithm processor.

30. The receiver of claim 25 wherein said receiver comprises a wireless receiver configured for use in a wireless communication network.

31. The receiver of claim 25 wherein said sub-optimal algorithm and optimal algorithm processors comprise at least one DSP programmed to perform sub-optimal and optimal processing of said received signal.

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